# PATENT COOPERATION TREATY

# PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

| Applicant's or agent's file reference P24726 | **FOR FURTHER ACTION** | See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416). |
|---|---|---|
| International Application No. **PCT/SG2002/000248** | International Filing Date *(day/month/year)* 24 October 2002 | Priority Date *(day/month/year)* 24 October 2002 |

International Patent Classification (IPC) or national classification and IPC

**Int. Cl.** [7] H03M 7/26, H04N 7/30

Applicant

LABORATORIES FOR INFORMATION TECHNOLOGY et al

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

   [X] This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 9 sheet(s).

3. This report contains indications relating to the following items:

   - I [X] Basis of the report
   - II [ ] Priority
   - III [ ] Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV [ ] Lack of unity of invention
   - V [X] Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI [ ] Certain documents cited
   - VII [ ] Certain defects in the international application
   - VIII [ ] Certain observations on the international application

| Date of submission of the demand | Date of completion of the report |
|---|---|
| 29 March 2004 | 16 September 2004 |
| Name and mailing address of the IPEA/AU<br>AUSTRALIAN PATENT OFFICE<br>PO BOX 200, WODEN ACT 2606, AUSTRALIA<br>E-mail address: pct@ipaustralia.gov.au<br>Facsimile No. (02) 6285 3929 | Authorized Officer<br>**SUSHIL AGGARWAL**<br>Telephone No. (02) 6283 2192 |

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/SG2002/000248

## I. Basis of the report

1. With regard to the **elements** of the international application:*

- [ ] the international application as originally filed.
- [X] the description, pages **1-29,** as originally filed,
  pages , filed with the demand,
  pages , received on with the letter of
- [X] the claims, pages , as originally filed,
  pages , as amended (together with any statement) under Article 19,
  pages , filed with the demand,
  pages **30-38,** received on **31 August 2004** with the letter of **31 August 2004**
- [X] the drawings, pages **1-3** , as originally filed,
  pages , filed with the demand,
  pages , received on with the letter of
- [ ] the sequence listing part of the description:
  pages , as originally filed
  pages , filed with the demand
  pages , received on with the letter of

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language which is:

- [ ] the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- [ ] the language of publication of the international application (under Rule 48.3(b)).
- [ ] the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- [ ] contained in the international application in written form.
- [ ] filed together with the international application in computer readable form.
- [ ] furnished subsequently to this Authority in written form.
- [ ] furnished subsequently to this Authority in computer readable form.
- [ ] The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- [ ] The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

4. [ ] The amendments have resulted in the cancellation of:
   - [ ] the description, pages
   - [ ] the claims, Nos.
   - [ ] the drawings, sheets/fig.

5. [ ] This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report*

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

| | | | |
|---|---|---|---|
| Novelty (N) | Claims | **1-19** | **YES** |
| | Claims | **None** | **NO** |
| Inventive step (IS) | Claims | **1-19** | **YES** |
| | Claims | **None** | **NO** |
| Industrial applicability (IA) | Claims | **1-19** | **YES** |
| | Claims | **None** | **NO** |

2. Citations and explanations (Rule 70.7)

Following documents were cited in the International Search Report:

D1: WO 2001/017268

D2: US 6433707

D3: EP 1030524

Claims 1-19 meet the criteria set out in PCT Articles 33(2)-(4) as none of the prior art documents teaches or fairly suggests a method of processing bit symbols by a data source as specified in the above claims.

What is claimed is:

1. A method for processing bit symbols generated by a data source, in particular a video, still image or audio source, comprising the following steps:

constructing a plurality of bit-planes using the bit symbols generated by the data source, each bit-plane comprising a plurality of bit-plane symbols;

scanning the bit-plane symbols of each bit-plane to generate a binary string of bit-plane symbols;

encoding the binary string of the bit-plane symbols using a statistical model, wherein the statistical model is based on statistical properties of a Laplacian probability distribution function which characterizes the data source.

2. The method according to claim 1, wherein the encoding of the binary string of bit-plane symbols is performed by an entropy encoder.

3. The method according to claim 2, wherein an arithmetic encoder is used as the entropy encoder.

4. The method according to any one of claims 1 to 3, wherein the Laplacian probability distribution function is defined by

$$f(x) = \frac{e^{-|x|\sqrt{\frac{2}{\sigma^2}}}}{\sqrt{2\sigma^2}}$$

wherein σ is the standard deviation of the Laplacian probability distribution function.

5. The method according to claim 4, wherein a probability assignment to each bit-plane symbol is determined based on the Laplacian probability distribution function and is used to determine the statistical model for encoding the binary string of bit-plane symbols.

6. The method according to claim 5, wherein the probability assignment to the bit-plane symbol is determined by

$$P_j = 1 - \left(1 + e^{-2^j\sqrt{\frac{2}{\sigma^2}}}\right)^{-1} \quad , \; j = M-1, \; M-2, \; \ldots$$

wherein

$P_j$ is the probability assignment to the bit-plane symbol, and
$j$ is the bit-plane.

7. The method according to claim 4, wherein a probability assignment to each bit-plane symbol is determined based on previously encoded bit-plane symbols.

8. The method according to claim 7, wherein the probability assignment to the bit-plane symbol is determined by

$$P_j = \frac{N_a}{N} P_j^{N_a} + \left(1 - \frac{N_a}{N}\right) P_j^{ML}$$

wherein

$P_j$ is the probability assignment to the current bit-plane symbol,
$j$ is the bit-plane,
$N_a$ is the number of bit-plane symbols coded until the end of the previous bit-plane,
$N$ is the number of bit-plane symbols coded until the current bit-plane symbol,
$P_j^{Na}$ is the estimation of $P_j$ after observing $N_a$ bit-plane symbols,
$P_j^{ML}$ is the maximum likelihood estimation of $P_j$ for the current bit-plane and is defined by

$$P_j^{ML} = \frac{\sum_{j=1}^{N-N_a} b_{i,j}}{N - N_a}$$

wherein $b_{i,j}$ is the bit-plane symbol.

9. The method according to claim 8, wherein the estimation of $P_j$ after observing $N_a$ bit-plane symbols, $P_j^{Na}$, is updated by

$$P_j^{N_a} = \frac{\sqrt{P_{j+1}^{N_a}}}{\sqrt{1 - P_{j+1}^{N_a}} + \sqrt{P_{j+1}^{N_a}}}$$

wherein $P_{j+1}^{N_s}$ is the estimation of $P_j$ from the previous bit-plane.

10. The method according to claim 4, further comprising the following steps:

determining an optimal bit-plane from the plurality of constructed bit-planes;

determining a probability assignment to each bit-plane based on its relation to the optimal bit-plane;

wherein the probability assignment to the bit-plane is used as the statistical model for encoding the binary string of bit-plane symbols.

11. The method according to claim 10, wherein the optimal bit-plane is determined by determining an integer which best satisfies

$$\phi^{2^{-L+1}} \le \theta < \phi^{2^{-L}}$$

wherein

$L$ is the integer representing the optimal bit-plane,

$\phi$ is defined by $\left(\frac{\sqrt{5}-1}{2}\right)$,

$\theta$ is defined as

$$\theta \triangleq e^{\sqrt{\frac{2}{\sigma^2}}}$$

12. The method according to claim 11, wherein the probability assignment the bit-plane is determined by

$$Q_j^L = \begin{cases} \dfrac{1}{1+2^{2^{j-L}}}, j \geq L \\ \dfrac{1}{2}, j < L \end{cases}$$

wherein

$Q_j^L$ is the probability assignment of the $j^{th}$ bit-plane.

13. The method according to claim 11, wherein the probability assignment to the bit-plane is determined by

$$Q_j^L = \begin{cases} \dfrac{1}{2^{2^{j-L}}}, j \geq L \\ \dfrac{1}{2}, j < L \end{cases}$$

wherein

$Q_j^L$ is the probability assignment of the $j^{th}$ bit-plane.

14. The method according to claims 6 or 8, further comprising the following steps:

decoding the encoded binary string of bit-plane symbols using a further statistical model to generate a further binary string of bit-plane symbols,

re-constructing a plurality of bit-planes comprising the bit-plane symbols using the further binary string of bit-plane symbols, wherein the further statistical model is based on statistical properties of a Laplacian probability distribution function which characterizes the bit-plane symbols of the reconstructed bit-planes.

15. The method according to claim 14, wherein the data source is re-constructed from the bit-planes by

$$\hat{x}_i = (2s_i - 1)\left( \sum_{j=M-1}^{T} b_{i,j} 2^j + \sum_{j=T-1}^{-\infty} P_j 2^j \right),$$

wherein

$\hat{x}_i$ is the re-constructed data source,

$s_i$ is a sign symbol of $\hat{x}_i$,

$b_{i,j}$ is the bit-plane symbol, and

$T$ is the bit-plane the encoded binary string of bit-plane symbols is terminated.

16. The method according to claims 12 or 13, further comprising the following steps:

decoding the encoded binary string of bit-plane symbols using a further statistical model to generate a further binary string of bit-plane symbols,

re-constructing a plurality of bit-planes comprising the bit-plane symbols using the further binary string of

bit-plane symbols, wherein the further statistical model is based on statistical properties of a Laplacian probability distribution function which characterizes the bit-plane symbols of the reconstructed bit-planes.

17. The method according to claim 16, wherein the data source is re-constructed from the bit-planes by

$$\hat{x}_i = (2s_i - 1)\left( \sum_{j=M-1}^{T} b_{i,j} 2^j + \sum_{j=T-1}^{-\infty} Q_j^L 2^j \right)$$

wherein

$\hat{x}_i$ is the re-constructed data source,

$s_i$ is a sign symbol of $\hat{x}_i$,

$b_{i,j}$ is the bit-plane symbol, and

$T$ is the bit-plane the encoded binary string of bit-plane symbols is terminated.

18. A device for processing bit symbols generated by a data source , in particular a video, still image or audio source, comprising:

a bit-plane construction unit for constructing a plurality of bit-planes from the data source, each bit-plane comprising a plurality of bit-plane symbols, and scanning the bit-plane symbols of each bit-plane to generate a binary string of bit-plane symbols,

a statistical model unit for providing statistical information based on statistical properties of a

Laplacian probability distribution function which characterizes the data source,

an encoding unit for encoding the binary string of bit-plane symbols based on the statistical information provided by the statistical model unit.

19. A computer readable medium, having a program recorded thereon, wherein the program is to make the computer execute a procedure for processing bit symbols by a data source, comprising the following steps:

constructing a plurality of bit-planes using the bit symbols generated by the data source, each bit-plane comprising a plurality of bit-plane symbols;

scanning the bit-plane symbols of each bit-plane to generate a binary string of bit-plane symbols;

encoding the binary string of the bit-plane symbols using a statistical model, wherein the statistical model is based on statistical properties of a Laplacian probability distribution function which characterizes the data source.

20. A computer program element which is to make the computer execute a procedure for processing bit symbols generated by a data source, comprising the following steps:

constructing a plurality of bit-planes using the bit symbols generated by the data source, each bit-plane comprising a plurality of bit-plane symbols;

scanning the bit-plane symbols of each bit-plane to generate a binary string of bit-plane symbols;

encoding the binary string of the bit-plane symbols using a statistical model, wherein the statistical model is based on statistical properties of a Laplacian probability distribution function which characterizes the data source, wherein the data source has a form of a Laplacian probability distribution function.